State-of-the-Art Reactor Consequence Analyses (SOARCA)

Semi-Annual Briefing for
Commission Technical Assistants
September 10, 2008

Agenda

- Project Status
- Results
- Updates / Insights

Project Status

- Plan to have the results of Peach Bottom & Surry in Dec. 2008
- Peer-Review to follow in Jan. 2009 if approved
- Sequoyah analysis in progress

Project Status (cont)

- SRM-SECY-08-0029
  - Approval for dose and spatial truncation methodology (option 6)
  - Approval for the external peer review
    - Plan completed
- Revised Statement of Work
  - Proposed external peer review
  - Uncertainty Analysis
    - Parameters have been identified, start date TBD
  - Risk Communication
- ACRS comments
  - Staff has taken steps or developed approach to address ACRS comments
    - Full scope level 3 PRA
    - Seismic impact on EP
    - Reporting health effects with LNT and a 5 Rem truncation value
  - Plan to provide ACRS written documentation of SOARCA approach, methods, and results for Peach Bottom and Surry (details in next slides)

ACRS Comments

- Full Scope level 3 PRA recommendation
  - Staff's view that SOARCA approach is appropriate
    - Consistent with objectives
    - Proper focus on detailed realistic modeling
  - Additional examination of SOARCA sequences
    - Comparison with NUREG-1150
    - Analysis of sequences with even lower frequency than 10^{-6} and 10^{-7} criteria
      - Peach Bottom Short-Term Station Blackout
    - Staff conclusions regarding lower frequency sequence demonstrated, by analysis, to be valid

ACRS Comments (cont)

- Seismic impact on EP
  - Primary influence is on evacuation time estimate (ETE)
  - Planned approach is to address by sensitivity analysis
  - Potential LERF impact
    - However, not expected for Peach Bottom and Surry
      - Magnitude of release
      - NA to Surry ISLOCA

Results

- Peach Bottom and Surry base cases (with B.5.b. measures implemented)
  - no early fatalities or latent cancer fatality risk (DBA-like release for Surry Short Term Station Blackout)
- Peach Bottom and Surry sensitivity cases (without B.5.b. measures)
  - no early fatalities; 10^{-4} to 10^{-3} conditional individual latent cancer fatality risk
  - 10^{-10} to 10^{-9} individual latent cancer fatality risk per sequence
    - Staff believes this metric could be used for risk communication when the base case results in an environmental release
    - Frames consequences in the context of a background risk and safety goals
  - The 10 mrem dose truncation value has no significant impact on the average individual risk (option 6); reconsider ACRS' recommendation of LNT and 5 Rem truncation value

Peach Bottom – STSBO

- Frequency: 1 – 5 x 10^{-7} / R-Y
- New case - below SOARCA screening threshold; added to address potential LERF concerns below screening criteria
- Base case with B.5.b. measures implemented – fission product release was prevented
- Sensitivity Case without B.5.b.measures (no Reactor Core Isolation Coolant System)
  - Release begins at ~8 hours,
  - Radiological Release – 11% iodine, 2% cesium (t=48 hours)
  - Not a LERF contributor

Peach Bottom – STSBO cont.

– no early fatalities

Distance Interval (mi)	Conditional Average Individual likelihood of a LCF	
	LNT	10 mrem truncation
0 – 10	9.7×10^{-4}	9.4×10^{-4}
0 – 50	1.6×10^{-4}	1.5×10^{-4}
0 – 100	1.0×10^{-4}	8.9×10^{-5}

Reconsider LNT and 5 Rem truncation value?

Peach Bottom Consequences

Scenario	CDF per R-Y	Early Fatalities	Conditional Individual LCF risk (0 -10 miles)	LNT – Individual LCF risk per sequence* (0 -10 miles)
Long Term Station Blackout (LTSBO)	1 to 5 x 10^{-6}	0	3 x 10^{-4}	8 x 10^{-10}
Short Term Station Blackout (STSBO)	1 to 5 x 10^{-7}	0	1 x 10^{-3}	3 x 10^{-10}

*U.S. average individual risk of a cancer fatality: 2 x 10^{-3} / year

Surry Consequences

Scenario	CDF per R-Y	Early Fatalities	Conditional Individual LCF risk (0 -10 miles)	LNT - Individual LCF risk per sequence (0 -10 miles)*
LTSBO	1 to 2 x 10^{-5}	0	1 X 10^{-4}	2 x 10^{-9}
STSBO	1 to 2 x 10^{-6}	0	6 x 10^{-4}	8 x 10^{-10}
STSBO / TISGTR	3 to 5 x 10^{-7}	0	9 x 10^{-4}	4 x 10^{-10}
$ISLOCA_{spar}$	3 x 10^{-8}	0	2 X10^{-3}	6 x 10^{-11}
$ISLOCA_{pra}$	7 x 10^{-7}	0	2 X10^{-3}	1 x 10^{-9}

*U.S. average individual risk of a cancer fatality: 2 x 10^{-3} / year

ISLOCA – Inter-systems loss of coolant accident

TISGTR – Thermally induced steam generator tube rupture

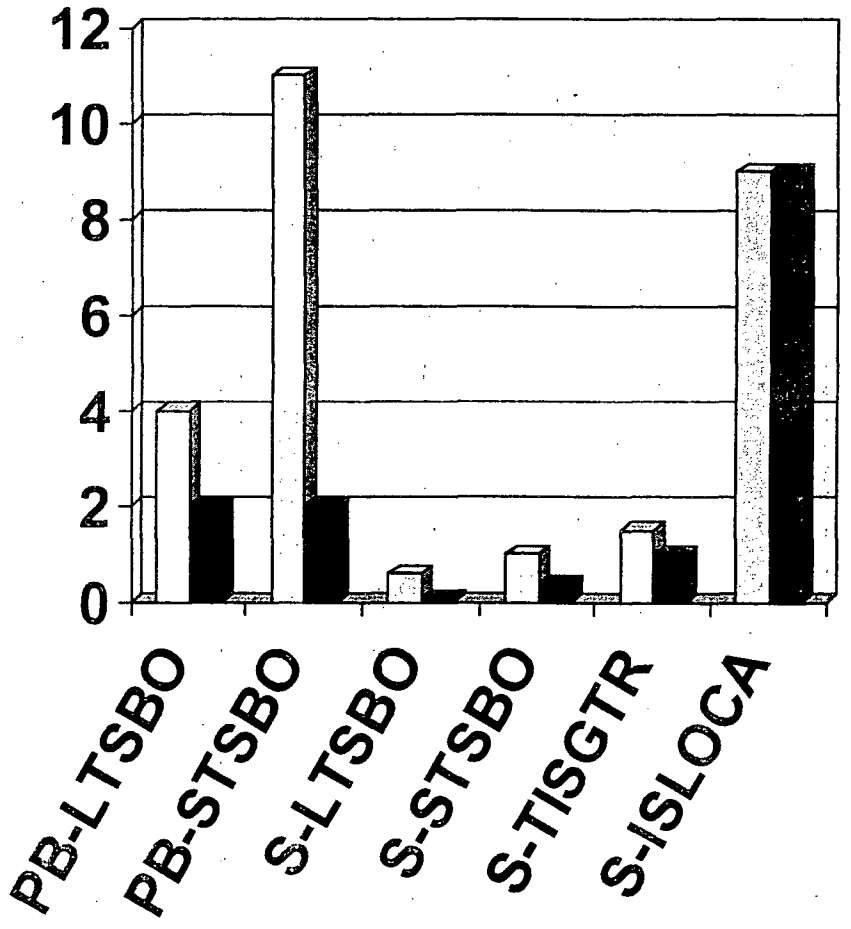
Surry ISLOCA

- Internally initiated event
- Sequence frequency
  - Licensee's PRA – 7×10^{-7} / year
  - SPAR – 3×10^{-8} / year (does not meet SOARCA screening criteria of 1×10^{-7} / year)
- Base case
  - Effectively mitigated – operators have sufficient time to switch to unaffected unit's refueling water storage tank (RWST) to prevent core damage
- Sensitivity
  - Assumes operators fail to switch to unaffected unit's RWST
  - Results in core damage and fission product release via the Safeguards Building

Surry ISLOCA – Sensitivity Analysis

- Break elevation is uncertain
  - NUREG-1150 concluded that the probability of break being uncovered is 0.15
- Sequence frequency
  - Based on licensee's PRA – 6×10^{-7} / year (covered), 1×10^{-7} / year (uncovered)
  - Based on SPAR – 3×10^{-8} / year (covered), 5×10^{-9} / year (uncovered)
- Preliminary results for sequence with break covered
  - Release begins at ~ 10 hours
  - Radiological Release – 9% iodine, 9% cesium
- Analysis ongoing for sequence with break uncovered

Release Magnitude (%)



Sandia Siting Study (SST1 source term)

Iodine – 45%

Cesium – 67%

Updates / Insights

- Propose truncating fission product releases to 24 hours after start of release
  - Generally consistent with NUREG-1150
  - Consistent with realistic consideration of anticipated EP measures and capabilities
    - Airlift capability if access limited

SOARCA Insights

- Because fission product releases are delayed and substantially smaller, offsite consequences are smaller than previously predicted
- No early fatalities; No LERF Contributors
- Average individual latent cancer fatality risks are very low
  - Most of the individual latent cancer risk is due to doses within the EPA Protective Action Guides and the assumed low dose health effects of the LNT dose response model

SOARCA Insights (cont.)

- Risk to the public from long term exposure is extraordinarily small
- Within the Emergency Planning Zone (EPZ)
  - For the BWR event (LTSBO) freq ~3 x 10^{-6} / year
  - Individual risk of a latent cancer fatality ~3 x 10^{-4} conditional to occurrence of event (LNT assumption)
  - Absolute LCF risk to individual is ~8 x 10^{-10} / year
  - Risk is thousands of times smaller than the NRC safety goal
  - Risk is millions of times smaller than all other cancer risks (2 x 10^{-3} / year)
- Risk outside the EPZ is smaller yet

- Questions?